COSMIC

COMPUTER SOFTWARE MANAGEMENT AND INFORMATION CENTER

DIRECTORY OF COMPUTER PROGRAMS

Volumes I and II -- March 1969

Supplement 2

N O T I C E

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DIRECTORY OF COMPUTER PROGRAMS AVAILABLE FROM COSMIC

March 1969

SUPPLEMENT 2 TO VOLUMES I AND II

INTRODUCTION

COSMIC (Computer Software Management and Information Center), located at the University of Georgia in Athens, Georgia, was conceived in July 1966 as a joint effort with the National Aeronautics and Space Administration for the dissemination of computer programs. During the development of the Space Program, efforts have been conducted in a wide variety of areas by NASA and their contractors. In many cases computer programs were necessary in reaching a solution to problems. NASA officials realized many programs could be useful to industry outside the area of space research.

Today NASA, the Department of Defense and the Atomic Energy Commission are combining efforts to make as many computer programs as possible available to the public. As this is accomplished, industry will save untold dollars by the use of the varied computer software.

At the University of Georgia, the COSMIC effort continues to grow. The technical areas of software contained in the library will fulfill a wide variety of industrial, research, and data processing requirements. In the near future other federal agencies will be joining forces by offering their computer software to the library and the variety of technical information will increase.

Subscription to the COSMIC catalogue is simple; a $10.00 fee, payable in advance, by any United States organization, or U. S. citizen. Members receive catalogues containing descriptions of available programs and of new programs as they are cleared for use. If one or more programs are purchased during the twelve months following initial membership, the literature will be available for the second year at no additional charge. If none are purchased, an additional payment of $10.00 will be necessary in order to continue receiving information.

If a program is ordered by an individual or organization that does not already receive the catalogue, free subscription for one year is given. If two or more programs are purchased and the organization wishes two or more copies of the catalogue, the same number of free subscriptions as programs ordered will be given but only upon written request furnishing customer number and address to which each copy should be sent.

CONTENTS OF THE CATALOGUE

KWIC - The KWIC includes all key words in a title indexed alphabetically according to individual key words. To the right of each title is the corresponding program number which is to be used to enter the Table of Contents for location and page number of the abstract.

KEY WORD - The Key Word Index is comprised of an alphabetical listing of all Key Words. A title does not completely describe the subject matter and the Key Words extracted from the documentation of all programs will facilitate locating a specific subject. To the right of the Key Word are the corresponding program number(s) which is(are) to be used to enter the Table of Contents.

TABLE OF CONTENTS - The Table of Contents consists of the program number and the page location of the program abstract.

ABSTRACT - The abstract is a short, concise, technical description of the computer program. It contains a description of the program, method of solution, the program language, and machine requirements.

INSTRUCTIONS FOR ORDERING

Upon payment of the membership fee or the purchase of a program, a customer number is assigned and, in ordering, the number should be utilized to expedite the request.

Orders for documentation or programs will only be accepted on official letterhead paper or by purchase order. Telephone orders must be confirmed in writing.

A separate price list is furnished showing documentation price; program price; and program and documentation price. Each order should specify exactly which item is desired. An order for DOCUMENTATION results in the receipt of DOCUMENTATION only. An order for PROGRAM only results in the receipt of the PROGRAM and NO DOCUMENTATION. An order specifying DOCUMENTATION and PROGRAM results in the receipt of both DOCUMENTATION and PROGRAM. This method was established because most users order the documentation first to determine whether they can use the program. If they later order the program deck or tape copy, there is no point in purchasing the documentation a second time.

SHIPPING METHODS

A program tape for dissemination is recorded as follows:

1. The tape is built on an IBM 7094.
2. A 7-track tape recorded at 556 bits per inch in card image format is provided.
3. Source and assembly records are 1 X 84 characters in size, and binary records are 1 X 168 characters in size.

4. The first card image is the program number, and the second card image is the program title.

5. A single program is ended by multiple EOF's (end of file). If several programs are ordered, each one is separated by 1 EOF and the last program is followed by multiple EOF's.

6. Upon completion of building the tape, it is dumped on an IBM 1401 and the dump will accompany the tape.

The standard DOCUMENTATION package for dissemination consists of a Xerox copy of the technical manuals corresponding to the program. Included is such information as the program description, method of solution, program language and machine requirements, input and output instructions and operating instructions. Also program timing, accuracy of results, and sample input and output are included when available. THE DOCUMENTATION DOES NOT INCLUDE A LISTING OF THE PROGRAM.

The above are standard specifications. Any special specifications will have to be arranged directly with COSMIC at the time the order is placed.

Since we pay all shipping costs, we reserve the right to select method of shipping but will in all cases use the fastest and most economical method.

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ABSTRACTS

A Method For Expanding A Direction Cosine Matrix Into An Euler Sequence of Rotations
(Ames Research Center)

This program converts a matrix of direction cosines into an equivalent Euler sequence by sequentially solving a given set of five equations. The first angle is used to compute the second and the second is used to compute the third. For a given direction cosine matrix, two solutions are possible. One solution is the result of a positive rotation, and the other is the result of a negative rotation. The program is operational throughout the entire 360^{o} angle range and also for singular cases. For such cases the equations become indeterminate; however, this problem can be resolved by the recognition that the two angles not involved in the singular condition simply add directly and that only their sum affects the direction cosines. Two sets of equations, one for the classical or repeating sequences and one for the nonclassical or nonrepeating sequences, are provided.

LANGUAGE: FORTRAN IV (37%), MAP (63%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 95

PROGRAM NUMBER: ARC-10163

Multiple Rank-Order Correlation Program (the Spearman Rho)
(Ames Research Center)

This program ranks raw data, selects one variable at a time, pairs it with another variable and computes a rank-order correlation. This process is repeated until each variable has been correlated separately with every other variable.

Each variable is ranked by assigning the rank of 1.0 to the highest value, 2.0 to the next highest, etc. Ties in the raw data values are adjusted by computing an average rank and assigning that rank to each of the tied data. After all data have been ranked, one set of ranks is subtracted from the other, the differences are squared, and the rank-order correlation coefficient is computed.

This procedure may be used (1) for small samples of data, (2) to obtain the relationship between two variables, one or both of which cannot be measured objectively, but which may be ranked subjectively, or (3) when other assumptions for parametric statistics cannot be met.

The program will process up to 100 cases for up to 30 variables. No data point may be larger than 999,998.9 nor less than 0.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 77

PROGRAM NUMBER: ARC-10165

Computer Program for Parameter Optimization
(The Boeing Company)

This program solves a wide range of multivariable parameter optimization problems by providing search techniques for the optimization of non-linear parametrically defined systems.

The program has the ability to solve constrained optimization problems involving up to one hundred parameters. Nine search techniques are available for problem solutions; they are: Sectioning, Adaptive Creeping, Steepest-Descent, Quadratic Search, Davidon's Method, Random Point Search, Random Ray Search, Pattern, and Magnification.

The searches may be employed separately or in any sequential combination. The optimization program may be rapidly coupled with a wide class of parameter optimization problems, including systems which have previously been synthesized as digital computer programs.

LANGUAGE: FORTRAN IV (84%), MAP (16%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 3,858

PROGRAM NUMBER: ARC-10168

Non-linear Differential Equation Integration
(Ames Research Center)

This subroutine package employs Chebyshev integration techniques to solve

(1) an nth order non-linear differential equation defined on the closed interval [-1, 1] and having n initial conditions, and/or

(2) a system of n first order non-linear differential equations defined on the closed interval [-1, 1] and having n initial conditions.

The subroutines accelerate convergence by the use of Aitken's formula. Derivative subroutines must be supplied by the user. The subroutines are written in double precision.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 374

PROGRAM NUMBER: ARC-10222

Star Detector System Analysis Program
(Electronics Research Center)

This program determines the voltage or current output from a star detector system when it is pointed at a star. It is also a research tool which will optimize an optical system-detector combination for a special task. The program provides a means for determining the required accuracy of stellar data for space flight. It can determine the output of 10 systems, each system with any of 10 detectors, using the input data from three sources for a total of 300 combinations.

Four of the functions of the program are: to determine the difference in output caused by the choice of input, to create stellar catalogs based on the detector sensitivity, to allow the optimization of system-detector combination, and to calculate the collector area for a desired signal-to-noise ratio.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 754

PROGRAM NUMBER: ERC-10163

GERT - Simulation Program for GERT Network Analysis
(Electronics Research Center)

The GERT Simulation Program can accommodate GERT networks which have EXCLUSIVE-OR, INCLUSIVE-OR and AND logical operations associated with the input side of a node. The branches of the GERT network are described in terms of a probability that the branch is realized and a time to perform the activity represented by the branch. The time associated with a branch can be a random variable.

The results obtained from the GERT simulation program are:

1. The probability that a node is realized
2. The average time to realize a node
3. An estimate of the standard deviation of the time to realize a node
4. The minimum time observed to realize a node
5. The maximum time observed to realize a node
6. A histogram of the times to realize a node

Normally this information is obtained for each sink node of the network. The program is written to permit the information to be obtained for any node specified in the input data. A comparison report is available which describesin detail the required input data.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 1130

NUMBER OF CARDS: Approximately 1,358

PROGRAM NUMBER: ERC-10209

Ratio Matching of Half-Bridge Weldable Strain Gages
(Flight Research Center)

Weldable half-bridge strain gages consist of two adjacent bridge resistances combined in the same package. It is possible to categorize these gages according to resistance ratio. Near zero unstressed output is obtained by using two half-bridge strain gages when the resistance ratio of one half-bridge gage closely matches the corresponding resistance ratio of the second half-bridge gage.

The program calculates the two resistance ratios of each half-bridge gage and outputs a table of gages ranked according to resistance ratio. The tabulation also includes the measured resistances and both calculated ratios, thereby forming a convenient record of gage characteristics.

For a particular installation, two adjacent half-bridge gages are selected from the computer tabulation. An adjacent half-bridge gage may be reserved in the tabulation as a spare in case one gage is inadvertently destroyed.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 42

PROGRAM NUMBER: FRC-10032

(TAPDIE) Thread Cutting With A 3-Axis N/C Milling Machine
(Langley Research Center)

Special jigs are usually required to cut threads, either in stock too big to mount on conventional machines, or in stock for which conventional methods are unsuitable.

TAPDIE, a generalized thread cutting macro, given the description of the desired thread, computes the machine tool path necessary to cut the thread. This information is passed on within the APT Computer System to a Post-processor which produces a control tape for the milling machine.

By using a tool bit that will cut a triangular groove equivalent to the desired thread pitch, a three-axis milling machine may be used. Flats on the thread face may be controlled to the extent of the machine tool tolerance limits.

TAPDIE will cut almost any type thread. The thread diameter is limited only by the size of the tool bit. Inside or outside threads, either left or right handed may be specified. The threads may be either straight or tapered with any desired number of threads per inch and pitch per thread.

LANGUAGE: CDC FORTRAN

MACHINE REQUIREMENTS: CDC-6600

NUMBER OF CARDS: Approximately 85

PROGRAM NUMBER: LAR-10017

Leading Characteristic Line Program
(Langley Research Center)

This program computes the leading characteristic line of a conical nozzle and punches cards to be used as input to a program that calculates the characteristic network of a jet boundary. The beginning flow angle between velocity and the x-axis (θ), the Mach number (M), a limiting Mach number, a Mach number increment and the pressure ratio (γ) are supplied. Other parameters are computed for each Mach number and the cards are punched to be used as input for the computer program which calculates the characteristics of a jet boundary.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 90

PROGRAM NUMBER: LAR-10118

Modified Multhopp Mean Camber Program
(Langley Research Center)

This program is designed to determine the mean camber surface required to support a given set of leadings on a composite wing in subsonic compressible flow. The program utilizes the modified Multhopp method for the mean camber surface determination. This method is used for the following reasons:

(1) The chordwise pressure distributions as well as overall aerodynamic characteristics are determined.

(2) The spanwise locations of the lift-producing singularities and control points are more concentrated along chordwise rows near the tip to insure an adequate representation of the spanwise load distribution.

(3) The method can be used for wings with planform kinks at locations other than just at the plane of symmetry.

The chordwise integration used in obtaining the solution utilizes the Gaussian quadrature method in order to increase the accuracy in representing the actual chordwise pressure distribution and in finding the influence of each of these distributions on each point where the boundary conditions are to be met.

LANGUAGE: CDC FORTRAN

MACHINE REQUIREMENTS: CDC 6000 series

NUMBER OF CARDS: Approximately 1,293

PROGRAM NUMBER: LAR-10376

Request Oriented Information Selection Program
(Lewis Research Center)

This program is a general purpose information retrieval program which can be used with any file of fixed format documents. It is easily used by noncomputer personnel and provides flexibility in search requests and output format. These features, together with efficient design, enable the program to satisfy the users' requests for information promptly and inexpensively.

The program incorporates the "and, or, and not" operators in the search operation. It also uses the following relational operators: greater than, less than, equal to, not equal to, greater than or equal to, less than or equal to. These relational operators are used in searching values of certain identifying numbers.

The reports to be searched are stored on magnetic tape, and at the beginning of each is a file of information which describes the format of the reports (directory file). The program reads the directory file which describes the documents on the search tape. To implement the program, one simply prepares search tapes whose directory files describe the new documents to be used. Next, the user's input cards (containing the search and output requests) are read and interpreted. Then the actual search begins and documents from the search tapes are compared to the search request, copied onto an intermediate tape when there is a match, and printed according to the user's output request.

LANGUAGE: FORTRAN IV (95%), MAP (5%)

MACHINE REQUIREMENTS: IBM 7094/7044 or 7040 direct coupled systems

NUMBER OF CARDS: Approximately 2,781

PROGRAM NUMBER: LEW-10255

Geometry and Design-Point Performance of Axial Flow Turbines
(Northern Research and Engineering Corporation)

This program was developed to solve the basic equations which govern the design-point performance of an axial flow turbine, avoiding lengthy and time-consuming numerical methods. The program is capable of analyzing both single and multispool units (a maximum of three spools is allowed).

The program will determine the standard turbine design parameters at a pre-selected number of streamlines. These parameters will be consistent with the requirement of radial equilibrium, the definition of blade element performance being used for the analysis, and the input specifications of design requirements and analysis variables when a valid solution of the design problem exists. When used for the analysis of a single spool, designs for any number of sets of analysis variables may be computed consecutively.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094/7044 DCS

NUMBER OF CARDS: Approximately 2,214

PROGRAM NUMBER: LEW-10471

Program Draws Three-Dimensional Surfaces (PLOT3D)
(Lewis Research Center)

PLOT3D is a package of programs to draw three-dimensional surfaces of the form $z = f(x,y)$. The function f and the boundary values for x and y are the input to PLOT3D. The surface thus defined may be drawn after arbitrary rotations. However, it is designed to draw only functions in rectangular coordinates expressed explicitly in the above form. It can't, for example, draw a sphere. Output is by off-line incremental plotter or on-line microfilm recorder. This package, unlike other packages, will plot any function of the form $z = f(x,y)$ and portrays continuous and bounded functions of two independent variables. With curve fitting, however, it can draw experimental data and pictures which can't be expressed in the above form.

The method used is division into a uniform rectangular grid of the given x and y ranges. The values of the supplied function at the grid points (x,y) are calculated and stored; this defines the surface. The surface is portrayed by connecting successive (y,z) points with straight-line segments for each x value on the grid and, in turn, connecting successive (x,z) points for each fixed y value on the grid. These lines are then projected by parallel projection onto the fixed yz-plane for plotting.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN IV	FORTRAN H
MACHINE REQUIREMENTS:	IBM 7094/7044 DCS with off-line CalComp plotter	IBM 360/67, Release 11 and on-line CDC microfilm recorder
NUMBER OF CARDS:	Approximately 370	Approximately 355
PROGRAM NUMBER:	LEW-10482	LEW-10482

Supersonic Flow Turbine Blade Design
(Lewis Research Center)

This program is for the design of supersonic blading based on establishing vortex flow within the blade passage. The method of characteristics, as applied to the two-dimensional isentropic flow of a perfect gas, was utilized for the blade design. The equations necessary for the design are developed. The information required for the program consists of an inlet flow angle; specification of the inlet, outlet, and lower-and upper-circular-surface Mach numbers; and the specific-heat ratio. The program output consists of the blade coordinates and, if desired, a printer plot of the blade profile and flow passage. In addition, supersonic starting and flow separation calculations are performed by the program and obtained as output. The output yields the nozzle contour for the supersonic portion.

The stator blades evolved by the program have sharp-edged throats so as to produce uniform parallel flow at the exit in the shortest possible length.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094/7044 Direct Couple System

NUMBER OF CARDS: Approximately 1,388

PROGRAM NUMBER: LEW-10575

Calculation of Isothermal, Turbulent Jet Mixing of Two Gases
(Lewis Research Center)

This program solves a simplified model of the turbulent mixing that occurs between a central fuel jet and a surrounding, faster-moving coaxial stream of propellant. The von Mises transformation was used to convert the axisymmetric forms of the isothermal boundary layer momentum and diffusion equations to forms amenable to numerical solution. The effects of confining walls were not considered. The program can solve problems in which the initial velocities and densities of the two streams differ greatly, by using expressions for eddy viscosity that vary radially as well as axially.

The input to the program consists of the initial ratio of coaxial stream velocity to jet velocity, the mass fraction of component one in the initial jet and in the initial coaxial stream, the ratio of molecular weight of component two to the molecular weight of component one, the constants in the eddy viscosity formulation, the turbulent Schmidt number, the ratio of reactor diameter to jet radius, the constants in the reference density formulation, and the axial positions at which output is desired.

At each axial position, the program prints out the axial position, the eddy viscosity, the product of density and eddy viscosity, and (for axial velocity, mass fraction, and mole fraction) the quantity:

(Centerline value-Coaxial stream value)/(1-Coaxial stream value).

The radial variations with stream function, also converted to radial position, and the ratio of radial position to half radius for axial velocity, mass fraction, and mole fraction are provided in the following form:

$$\frac{\text{(Local value - Ambient stream value)}}{\text{(Centerline value - Ambient stream value)}}$$

Also listed are momentum flux normalized with the square of the centerline velocity, mass flux normalized with the product of centerline velocity and mass fraction, and eddy viscosity and the product of density and eddy viscosity divided by their centerline values. Both sides of the centerline compatibility condition are printed next, followed by the values of velocity and density at the largest stream function

(continued on next page)

position in the calculation. Finally, the "line of sight" concentration, the dimensionless mass of component one, and the ratio of mass of component one to initial mass are listed.

LANGUAGE: FORTRAN IV (65%), MAP (35%)

MACHINE REQUIREMENTS: IBM 7094/7044 DCS

NUMBER OF CARDS: Approximately 774

PROGRAM NUMBER: LEW-10579

BROOT
(North American Rockwell-Rocketdyne Division)

This program find roots of polynomials of up to the 100th degree. It performs this function by obtaining second degree factors for the polynomial using the Bairstow procedure in double precision arithmetic. If this fails, the polynomial is converted into one in which the roots are the squares of the actual roots. The Bairstow procedure is then repeated. This squaring process is repeated until it is successful or until overflow occurs. If overflow occurs, the Bairstow procedure is repeated for the original polynomial and the roots are returned and identified as questionable.

The theory behind this procedure is that the Bairstow process has difficulty with polynomials which have roots of the same magnitude. Unless they are exactly equal, the squaring process will separate the roots. This procedure is a modification of the Graeffe root squaring process.

This program is very fast. Polynomials of up to the 50th degree, all with root magnitude of approximately 1, can be factored in less than one minute.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 248

PROGRAM NUMBER: MFS-1502

Statistical Analysis Program
(North American Rockwell-Rocketdyne)

The Statistical Analysis Program uses statistical analysis to compute the mean, standard deviation, coefficient of variation, and lower tolerance limits of material property values. One guaranteed minimum value uses three standard deviations. The other uses a multiplier (K) from a table of factors for one-sided tolerance limits. The arithmetic mean, standard deviation, coefficient of variation, and two guaranteed minimum values can be calculated for sets of observations in which the frequency is greater than 1. The probability and confidence are not used in any calculations except in determining the value of K by table reference. U (units) is used to differentiate whether observations are in pounds per square inch or kilograms per square inch. In case of elongation, the percent is in U inches.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 73

PROGRAM NUMBER: MFS-1632

Mechanized Products Scheduling System
(North American Rockwell-Rocketdyne)

This program utilizes PERT, line-of-balance, and CPM concepts and principles in a simple format that can be readily updated in the projection of schedules for hardware and tasks. It establishes a more positive position for the control of accurate scheduling of hardware and software items.

All output is in CRT formats, consisting of bar charts listing all part numbers and plotting. Included in this are engineering design and detailing, engineering check and release, material preparation and deletion, fabrication and processes, and assembly data in relation to time increments. Data is listed in sequential numbers, and load distribution curves are plotted from accumulated data.

This program is used as a scheduling and planning tool to coordinate timing of technical and administrative efforts for efficient utilization of facilities and manpower to deliver hardware and complete tasks on schedule.

LANGUAGE: FORTRAN IV (12%), MAP (88%)

MACHINE REQUIREMENTS: IBM 7094/7044 DCS, SC 4020 Plotter

NUMBER OF CARDS: Approximately 7,905

PROGRAM NUMBER: MFS-1647

Interface Mass Transfer
(Boeing Company)

This program calculates the mass transfer, either condensation or evaporation, at the liquid-vapor interface of a LOX tank. The program can be used for such purposes as a parametric study to obtain an indication of the magnitude of the interface mass transfer in the Saturn VS-IC stage LOX tank.

The method used applies to a saturated liquid which is suddenly pressurized and maintained at that pressure. The LOX is considered as a semi-infinite solid while the vapor is handled in a manner which allows one dimensional fluid flow. Such flow is required if mass transfer is to occur at the interface.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 709/7090

NUMBER OF CARDS: Approximately 97

PROGRAM NUMBER: MFS-1672

General Least Squares Solver of Linear Equations
(Chrysler)

This program gives the least squares solution to a system of over-determined linear equations BX=C, where B is a NxM matrix with N>M and C a column vector of dimension N. A maximum of 100 equations in 24 unknowns may be used.

Time for a typical run is from a minimum of one minute to a maximum of four minutes. The output consists of the program title printed as the main heading, print-out of the augmented matrix by rows, then a print-out of the solution by rows.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 91

PROGRAM NUMBER: MFS-2109

Linear Algebra
(Chrysler)

This program reduces and revises systems of linear equations into simpler systems and into a more useful system. For example, if one had a group of equations and wanted to solve for some of the variables in terms of other variables this system would overcome the tedious algebra that would be necessary. This is especially applicable in structures where a system would be replaced by its equivalent stiffness equations.

As an example of this, imagine a system such as:

D(A)	T(A)	M(A)	H(A)	D(B)	T(B)	M(B)	H(B)	= CONST.
X		X	X			X	X	X
	X	X	X			X	X	X
		X	X	X		X	X	X
		X	X		X	X	X	X

The program can convert this into:

D(A)	T(A)	M(A)	H(A)	D(B)	T(B)	M(B)	H(B)	= CONST.
1				X	X	X	X	X
	1			X	X	X	X	X
		1		X	X	X	X	X
			1	X	X	X	X	X

By rearranging the variables, different quantities can be solved for.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 58

PROGRAM NUMBER: MFS-2111

POLYGN-FORTRAN H Function Subprogram
(North American Rockwell-Rocketdyne)

The purpose of this function subprogram is to compute the area of a simple closed polygon (a polygon whose sides intersect only at the vertices) as follows:

(1) Choose any vertex as the first element of the set.
(2) Proceed along an adjacent side to the next vertex. This is the next element of the set.
(3) Maintaining the sense of direction, repeat step (2) until all N vertices are contained in the set.
(4) The area is computed using the following formula:

$$\text{Area} = 1/2\left|\sum_{i=1}^{n-1} (X_iY_{i+1} - Y_iX_{i+1}) + Y_1X_n - X_1Y_n\right|$$

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 28

PROGRAM NUMBER: MFS-2365

EVALUE Subroutine
(North American Rockwell-Rocketdyne Division)

This subroutine uses the Threshold Jacobi method to determine the characteristic roots (eigenvalues) of a real, symmetric matrix. A user option provides for the calculation of the matrix of associated eigenvectors.

Basically, the subroutine diagonalizes a real, symmetric matrix. The problem as stated in matrix equations form is $AU = U\Lambda$ where A is a given nth order real, symmetric matrix and Λ and U are the solution matrices of the eigenvalues and corresponding ortho-normalized eigenvectors.

The maximum order of the input matrix is 50. An optional feature of the program is the generation of the original matrix A from the solution matrices Λ and U.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN H	FORTRAN IV
MACHINE REQUIREMENTS:	IBM 360, Release 11	IBM 7094
NUMBER OF CARDS:	Approximately 130	Approximately 135
PROGRAM NUMBER:	MFS-2366	MFS-13289*

*This listing supersedes page 195 of Volume I and II.

Bessel Library Subroutine (BESEL)
(North American Rockwell-Rocketdyne)

This subroutine computes the I, J, K and Y Bessel functions to any given accuracy. If the specified accuracy can not be obtained, the program so indicates. In all cases the zeroth order function is first calculated by means of either a Taylor or an asymptotic series, depending upon the size of the argument. Higher order functions are then computed by means of recurrence formulas. The Allen polynomial approximation table can be used in the case of the K Bessel function. This program is written in double precision.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 192

PROGRAM NUMBER: MFS-02367

Calculation of Eigenvalues and Eigenvectors of Arbitrary Matrices (North American Rockwell-Rocketdyne Division)

This program uses a modification of the Greenstadt method to calculate the eigenvalues and eigenvectors of an arbitrary complex matrix.

Basically, the matrix is reduced to upper triangular form. Elements in the lower triangle (called pivot elements) are driven to zero through the application of a sequence of unitary transformations. The sequence of operations upon the set of pivot elements is called a pass. The algorithm continues until a specified maximum number of passes has been made or until the average modulus of the set of pivot elements has been reduced to a particular value. The maximum order of the input matrix is 40.

The triangularized matrix (labeled "Eigenvalue Matrix") is output in two parts, the real part and the imaginary part. The eigenvalues appear on the main diagonal, real part and imaginary part. The vector matrix of the triangularized system (in similar format) follows. Finally, the eigenvector matrix of the original system is output.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN H	FORTRAN IV
MACHINE REQUIREMENTS:	IBM 360, Release 11	IBM 7094
NUMBER OF CARDS:	Approximately 298	Approximately 303
PROGRAM NUMBER:	MFS-2368	MFS-13287*

*This listing supersedes page 194 of Volume I and II.

Matrix Manipulator Program
(North American Rockwell-Rocketdyne Division)

This program performs a combination of matrix, vector, and scalar operations including addition, subtraction, multiplication, inversion, diagonalization, transposition and trace computation. In addition, the programs will execute element for element multiplication and division. The program also has the capability of performing elementary transformations on the elements of the matrices. A total of twenty-two operations are available.

The program will accept up to sixty-six input matrices, each of which may have up to fifteen rows and fifteen columns. Thirty-three operations may be performed for each case.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 506

PROGRAM NUMBER: MFS-2369

Bellows Calculation Program
(North American Rockwell-Rocketdyne)

This program employs empirical and analytical derived design equations on various metal bellows of different sizes in order to calculate various properties of bellows used in ducting systems. Arithmetic operations are performed in double precision. Calculations are restricted to four single bellows movements and two double bellows movements. One subroutine and one data deck are required with the main program.

The main program and the subroutine calculate bellows spring rates, bulging, bending, and hoop stresses. Cycle life is calculated by the data deck. With known bellows dimensions and type of movements supplied as data, the main program and subroutine calculate spring rate, actuating force, squirming pressure, stress, bellows weight, resonant frequency, fatigue life and convolution clearing.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 371

PROGRAM NUMBER: MFS-12641

Bladed Wheel Assembly for Minimum Imbalance
(North American Rockwell-Rocketdyne)

This program is designed to determine the best possible arrangement of a given collection of pump or turbine blades for minimum imbalance, on disks of predetermined imbalance. Input consists of an array of actual blade weights, linear regression coefficients A and B for the established relation between weight (W) and moment (M), about the center of the wheel:

$$M = AW+B,$$

and a number of entries specifying disk imbalance, total number of blades, number of blades per wheel (book) and number of wheels to be bladed. Each blade has a preassigned number which is input along with its weight.

The entire number of blade weights is sorted and listed in order of increasing weight. Each disk is then theoretically bladed with the proper number of blades taken from the sorted list (up to 500 per disk), and then rearranged for minimum total imbalance of disk plus blades. The final position sequence is printed out with associated blade numbers and weights. The process is repeated for each of up to 5 more disks.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN IV	FORTRAN H
MACHINE REQUIREMENTS:	IBM 7094	IBM 360, Release 11
NUMBER OF CARDS:	Approximately 523	Approximately 517
PROGRAM NUMBER:	MFS-12941	MFS-13026

Research Multiple Correlation Computer Program
(North American Rockwell-Rocketdyne)

This is a general purpose computer program that uses the classical method of multiple correlation to estimate $B_1, B_2, \ldots B_n$ in the equation $X_1 = B_1 + B_2X_2 + B_3X_3 + \ldots B_nX_n + \epsilon$. X_1 is the dependent variable. $X_2, \ldots X_n$ are independent variable functions with zero mean and variance σ^2. Each function X_j, $j = 2, \ldots n$ can contain no more than three independent variables and must have the algebraic form of a simple product, exponential, fractional power, logarithm, or polynomial of degree less than five.

Estimates of the regression coefficients and their standard deviations, together with the multiple correlation coefficient, individual correlation coefficients and partial correlation coefficients, are provided in this program. All estimates are statistically evaluated and their associated confidences computed. The program also performs a chi-square test for normality on the residuals to permit evaluation of the normality assumption. An optional procedure to find a final regression with a minimum number of independent functions X_j is provided in the program.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 755

PROGRAM NUMBER: MFS-13024

Principal Axis Computation (7R080)-FORTRAN H Version for System 360 (North American Rockwell-Rocketdyne)

This program is designed to compute accurate values of principal axis directions and moments of inertia about these axes for any component or group of components, the mass properties of which are known with respect to some other reference coordinate system. Six parameters are required as input: three values for moments of inertia and three for the products of inertia. These inputs are taken about a reference system of cartesian coordinates originating at the center of gravity of the total mass under consideration. Input parameters are printed with the output. The only restriction is that all six inputs must be expressed in identical units.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 79

PROGRAM NUMBER: MFS-13025

Blade Frequency Program (7R-638) - FORTRAN H Version
(North American Rockwell-Rocketdyne)

This program is designed to determine turbine blade natural frequencies. The program computes the bending vibration (natural) frequency of a turbine blade, considering the stiffening effect of the wheel speed. The three lowest natural frequencies and corresponding mode shapes of the turbine blade are determined and treated as a cantilever beam. The stiffening effect of blade rotation about an axis perpendicular to the plane of beam bending is considered.

The method was derived from a vibration analysis report where the bending vibration can be transformed to tangential vibration.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 128

PROGRAM NUMBER: MFS-13038

Solution of Differential Equations Using the Nordsieck Method - DENORD
(North American Rockwell-Rocketdyne)

This subroutine solves an Nth order system of first order ordinary differential equations using the method described in the following:

"On Numerical Integration of Ordinary Differential Equations", Arnold Nordsieck, Mathematics of Computation 16 (1962), pp. 22-49.

This method, which is stable under all circumstances, incorporates automatic starting with automatic choice and revision of integration step size. In addition, the amount of computation for a specified accuracy is approximately minimized. All arithmetic calculations are performed in double precision. This technique may be applied to any system of differential equations with derivatives which are either continuous or piecewise continuous with finite jumps.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 204

PROGRAM NUMBER: MFS-13122

Plume Radiation Program
(North American Rockwell-Rocketdyne Division)

This program determines the radiant flux to the base region of a gas system with an axisymmetric geometry and any axisymmetric property distribution. The gray gas simplification is not made and interlayer absorption is accounted for; i.e., no simplifying assumption is made as to the magnitude of the optical thickness. The effect of the shadow or silhouette of any axisymmetric occlusion is also included in the analysis. The simultaneous emission and absorption of various radiating species is accommodated. The analysis also accounts for the radiative emission and absorption due to an afterburning mantle with variable temperature, pressure, and chemical composition along with the absorption of radiation by an intervening atmosphere.

The geometric configuration factor of the entire plume surface is also computed as a matter of interest. For cases in which it is valid to assume that the gas system radiates as an opaque diffusely radiating surface, a "shell model" can be used based on this configuration factor. Due to the complexity of the functional relationships of the pertinent parameters a numerical integration technique is necessary.

LANGUAGE: FORTRAN IV

MACHINE REQURIEMENTS: IBM 7094

NUMBER OF CARDS: Approximately 1,457

PROGRAM NUMBER: MFS-13202

Analysis of an Incompressible Fluid Flowing in Radial Equilibrium
(North American Rockwell-Rocketdyne)

This program, consisting of three parts, is designed to analyze an incompressible fluid flowing in radial equilibrium.

Case No. 1 uses Euler's equations of motion to calculate the axial velocity of an incompressible fluid flowing in radial equilibrium. All velocities from hub to tip between blade rows must be known in order to determine the blade profiles. A numerical solution is used to solve for continuity, except in a case of constant velocity. The values of blockage factor and density are used as inputs with two guesses as to axial velocity at the tip. The program uses these values to interpolate linearly and then with a progressively higher order curve fit for continuity.

Case No. 2 uses numerical integration to calculate static pressures for the same problem. Inputs to this case include hub and tip radii, blockage factor, density, and total head and angle. Radial velocities are assumed negligible. Two guesses must be made as to absolute velocity at the tip. A velocity given with no equilibrium solution will print out "V2 has a negative radicand." Since the solution is sensitive to two guesses of axial velocity, several additional values should be tried before the solution is abandoned as impossible.

Case 3 is designed to calculate the axial velocity of an incompressible fluid flowing in radial equilibrium. It is a modification of Case 1 to force the computer to calculate a constant axial velocity, particularly if the basic design of the axial-flow pump involves long blades. The program features an averaging technique that will give an axial velocity to an exact constant. It is assumed that the fluid head is constant regardless of blade length. From hub to tip, the flow is free vortex and the axial velocity is constant.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 363

PROGRAM NUMBER: MFS-13221

Double-Circular-Arc Airfoil Program
(North American Rockwell-Rocketdyne)

This program calculates the radii for the upper surface, the lower surface and the mean line of a double-circular-arc airfoil. Output also includes the airfoil coordinates, the area and the center of gravity.

To aid the designer in making a pump layout, the total projected length of the airfoil (parallel to the pump axis) is expressly stated in the output along with the forward portion of this length from the center of gravity.

This program will be useful in aircraft, rotary wing airfoil design or underwater application in the design of axial flow type blades and control airfoil.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 129

PROGRAM NUMBER: MFS-13222

Coordinates of a NACA 65 Series Airfoil Program
(North American Rockwell-Rocketdyne)

This program computes the coordinates, area and center of gravity of an NACA 65-series airfoil. The lift coefficient, for which the airfoil is to be cambered, becomes one of the inputs along with a Hollerith description card. Coordinates for a thinner or thicker section may be computed using the conversion factor:

$$K = \frac{\text{percent thickness desired}}{10.114}$$

The coordinates, as given, result in a trailing edge thickness of only 0.3 percent of the chord. Because of casting or machining difficulties or a stress concentration, it is often necessary to increase the thickness of the trailing edge. It is possible to do this with an input to the program.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 157

PROGRAM NUMBER: MFS-13223

Least Squares Curve Fit Program
(North American Rockwell-Rocketdyne Division)

This program fits a set of data points with a linear combination of a user prescribed set of general functions of one or more independent variables. Execution of the program requires three subroutines which must be supplied by the user. The first of these is a subroutine which performs any necessary data transformations. The second and third subroutines must be provided to evaluate both the function and the partial derivatives of the function with respect to the unknown parameters.

The number of functions, unknown parameters, and floating point constants must be less than or equal to 20; the number of independent variables must be less than or equal to 5; the number of fixed point constants must be less than or equal to 10; and the number of observations must be less than or equal to 400. The program is written in double precision.

The program contains a subroutine package which will produce graphical output with raw data and estimated data on one frame, and the deviation vs. the independent variable on a second frame.

LANGUAGE: FORTRAN IV (38%), MAP (62%)

MACHINE REQUIREMENTS: IBM 7094, SC 4020 plotter (optional)

NUMBER OF CARDS: Approximately 3,878

PROGRAM NUMBER: MFS-13252

Automated Flowmeter Calculation
(North American Rockwell-Rocketdyne)

This program utilizes a method whereby the propellant tank incremental liquid level gage information was digitized and recorded by the automatic data acquisition system. Separate counters were installed in the acquisition system to accumulate the flowmeter output pulses. The program provides automatic determination of the flowmeter constant from these recorded data. The previously calibrated tank volumes between liquid level gage increments, the time difference between gage switch closures, and count of the flowmeter between the gage increments are applied to the computer to provide a flowmeter constant. This system replaces a method of recording the flowmeter output pulses and the incremental liquid level switch gage simultaneously on oscillograph and counting the number of pulses between switch gage increments by hand to determine the constant.

LANGUAGE: DAP Assembly

MACHINE REQUIREMENTS: DDP-24

NUMBER OF CARDS: Approximately 277

PROGRAM NUMBER: MFS-13259

Assembly Processor Program for CDC 924A
(North American Rockwell-Space and Information Systems Division)

The assembly processor program accepts input cards written in a symbolic language and converts each to the appropriate machine instruction.

The program operates on each language statement twice, once during each of two passes of those statements through the processor.

Pass 1 accepts the source language statements from either punched cards or a combination of an output listing from a previous assembly and punched change cards. The source statements are broken down into fields - location, octal operation code, B-term, and variable field. Five statements are processed; whereupon, the five statements, along with the fields, are written on MT3. Also during Pass 1, each symbolic location term is equated to a relocatable octal address and the pair is stored in core tables.

Pass 2 reads the records on MT3 and processes the B-terms and the variable field (M-term). A listing tape is generated, an object deck is punched (if not suppressed), and images of the object deck are written on MT4 (if not suppressed).

LANGUAGE: Any symbolic language found in the CDC or IBM (SHARE) reference manual.

MACHINE REQUIREMENTS: CDC 924A

NUMBER OF CARDS: Approximately 5,149

PROGRAM NUMBER: MFS-13262

ANOVA Computer Program
(North American Rockwell-Rocketdyne)

The PL1 computer program known as ANOVA performs a simple one-way (i.e., among and within groups) analysis of variance. In addition it sorts the data (according to the magnitudes of the observations) within each group and calculates certain basic statistics. This program should prove useful in many engineering applications, for example: (1) the assessment of variation among items from several lots (or heats or manufacturers) and (2) the estimation of engine-to-engine and run-to-run variability. Outputs from the program include:

1. A listing of the original data.

2. A listing of the data after the observations have been arranged in order of magnitude within each group.

3. For each group: (a) total, (b) group size (n), (c) mean, (d) uncorrected sum of squares, (e) correction factor, (f) corrected sum of squares; i.e., sum of squares of deviations about the mean, (g) variance, (h) standard deviation, (i) coefficient of variation, (j) standard error of the mean, (k) largest value in the group, (l) smallest value in the group, (m) range, (n) midrange

4. For all the data (i.e., all groups combined): (a) total, (b) total number of observations, (c) mean, (d) uncorrected sum of squares among groups, (e) correction factor; i.e., sum of squares due to the mean, (f) among groups sum of squares, (g) within groups (experimental error) sum of squares, (h) total sum of squares [(e) + (f) + (g)], (i) group mean square, (j) error mean square, (k) F-ratio, (l) numerator and denominator degrees of freedom associated with the F-ratio, (m) estimate of the "groups" component of variance

Both the number of groups and number of observations in each group must be at least 2 and cannot exceed 100. Multiple case jobs may be run.

LANGUAGE: PL1

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 136

PROGRAM NUMBER: MFS-13297

ASCII Conversion Program
(North American Rockwell-Rocketdyne)

The American Standard Code for Information Interchange (ASCII) Conversion Program utilizes the paper tape punch unit of the DDP-24 computer to generate 8-bit octal source tapes necessary for the assembly of DDP-116 programs using in-plant facilities.

The program processes as many as 99 source decks that have been previously keypunched from code sheets and loaded onto magnetic tape, each deck being separated. Each DAP source card image is represented on magnetic tape as an 80 character record and the program reads and converts any combination of the 36 character set composed of the alphabet and the 10 numeric digits plus certain special characters (e.g., $ dollar sign, * asterisk, + plus sign, etc.). Use of a character other than those will halt the conversion process with an appropriate typewriter comment.

LANGUAGE: DAP Assembly

MACHINE REQUIREMENTS: DDP-24

NUMBER OF CARDS: Approximately 490

PROGRAM NUMBER: MFS-13540

Mixture Ratio and Monitor Program (VST-1)
(North American Rockwell-Rocketdyne)

The VST-1 test program consists of a series of thrust chamber start transient tests, each with a maximum duration of ten seconds. It was decided that only a limited quantity of these chambers were to be allocated for testing and that a LOX rich mixture ratio condition could severely jeopardize test hardware and scheduling. Therefore, stringent tolerances were established on propellant mixture ratio to provide maximum safety for test hardware.

This program monitors on-line propellant mixture ratio and instrumentation malfunctions and checks incoming critical parameters for minimum and maximum limits. If the limits are exceeded, it generates a cut-off signal. If these parameters are within the specified limit, it then calculates mixture ratio, using the slope from the last two mixture ratio points to report the next value of mixture ratio. It also checks the former against their limits and, if necessary, initiates a cut-off signal. The program is capable of completing this sequence of events well within one sweep of data, 12ms; this limits the possibility and/or extent of damage to the hardware, because of the delay between the occurrence of an out-of-control parameter and generation of a cut-off signal.

When a cut-off signal is sent, a post test message is output, providing the time and the cause of the cut. In addition, the program checks pre-test electrical calibrations for critical parameters and alerts the computer operator of possible malfunctions.

LANGUAGE: Digital Assembly Program (DAP)

MACHINE REQUIREMENTS: Honeywell, Model DDP-24

NUMBER OF CARDS: Approximately 1,948

PROGRAM NUMBER: MFS-13543

ORFCAL Program
(North American Rockwell-Rocketdyne)

This program is written to reduce calibration with square root scale instruments. The program is so written to allow the input of calibration data from an orifice calibrated using square root, 0 to 100 percent, delta "P" gauges. This program should not be used for direct-reading gauges.

Input is restricted to no less than 3 nor more than 23 sets of data for each case. The printout consists of various data related to the orifice size, gauge range, gauge indication factor and average values of the gauge factor. Other output consists of flowrate, which is the product of the gauge factor and gauge indication, coefficient of variation, and $\pm$ error of the average value of the gauge factor at the 99.7 percent confidence level.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 112

PROGRAM NUMBER: MFS-13692

General Thrust Chamber Contour and Tube Dimensions
(North American Rockwell-Rocketdyne)

This program determines the general contour and tube dimensions of a thrust chamber tube with a given contour defined by lines, circles or conics. The program sets up corresponding algebraic expressions and computes intermediate points on the contour at specified intervals, computes angles and their functions at these points, computes arc length within a given area, calculates tube cross-sectional dimensions and computes hydraulic diameters, perimeter and areas of tube cross-sections. Many other pertinent calculations and computations are featured in the program, along with a card punchout for any part of the data. A plot capability for the Orthomat, depicting tube contour and cross-section configuration, is also featured.

The method employed is faster and generates more data reference points, resulting in greater accuracy and more complete output description. Additional points are generated particularly along the contour where curvature is steep.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 4,382

PROGRAM NUMBER: MFS-13867

Alternating Current Circuit Analysis
(The Boeing Company)

The A-C analysis program is used by an electronic design engineer to aid in designing and analyzing linear A-C circuits. The program automatically sets up nodal equations from a description of the linear A-C circuit. Topological descriptions of the circuits to be analyzed are input. All parameter units are assumed to be in volts, ohms, amps and watts, although a consistent scaled system may be used. Various matrices are generated from the nodal description. The equations are solved for the node voltages which in turn are used to calculate the voltage drop, current and power dissipation in each circuit component. It also checks the integrity of the network and its function. There is no limit to the number of circuits that may be analyzed in a single computer run.

Since the program can analyze any number of circuits per run and gives very detailed results for each circuit, the program will result in a very significant tool in automated circuit design.

LANGUAGE: FORTRAN IV (91%), MAP (9%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 1,341

PROGRAM NUMBER: MFS-14534

Performance Analysis of Electrical Circuits (PANE)
(The Boeing Company)

PANE is an automated statistical and worse case IBM system 360 computer program designed to perform d-c and a-c steady state circuit analyses. The program writes a set of real (d-c analysis) or complex (a-c analysis) circuit equations in matrix form from a topological description of the circuit components and their interconnections. The program determines the worse case circuit performance by solving the circuit equations with each input toleranced to produce the minimum and maximum value of each output parameter. The program also performs a Monte Carlo Statistical analysis by solving the circuit equations repeatedly, using random selections of the input parameter values, according to user specified density distributions, thereby producing a statistical variation of each output parameter.

The program accepts 200 inputs, each specified with its appropriate tolerances according to density distribution (accepts six different distribution shapes) desired for either a-c or d-c analysis. The d-c analysis program accepts resistors, independent voltage and current sources, voltage dependent current sources, transistors and diodes. The diodes are described by measured I_D vs V_D characteristics; the transistors use the Ebers-Moll large signal model described by I_e vs. V_{BE} and I_s vs. V_{BC} measured characteristics supplied by tables.

The program handles 60 dependent nodes (other than ground or those connected to independent voltage sources). The a-c program accepts resistors, capacitors, inductors, independent voltage and current sources, voltage dependent current sources, any a-c equivalent transistor model using voltage dependent current sources, and diodes represented by their a-c equivalent.

A maximum of 50 outputs may be requested, indicating worse case performance in tabular form showing the minimum, maximum and nominal values calculated. Statistical behavior of outputs is given in tabular form and histogram plots. A-C circuit performance is given in tabular form and histogram plots for statistical analysis. Worse case performance as a function of frequency is given in tabular form with code plots showing the minimum, maximum and nominal response for each output quantity. The program also outputs sensitivity tables

(continued)

which determine the effect of component statistical variations on the output parameters.

LANGUAGE: FORTRAN H (66%), Assembler (34%)

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 5,600

PROGRAM NUMBER: MFS-15001

CIRCUS - A Digital Computer Program For Transient Analysis Of Electronic Circuits
(Boeing Company)

This program is designed to simulate the time domain response of an electronic circuit to an arbitrary forcing function. CIRCUS uses a charge-control parameter model to represent each semiconductor device. When given the primary photocurrent induced in the semiconductor devices, the transient behavior of a circuit in a radiation environment can be determined.

The program initially sets up time-domain circuit equations from a topological description of the network. Steady-state initial conditions are found by setting the differential equations to zero, then evaluating the transient solution by numerical integration of the differential equations.

The program output includes the input data and columnar listings of network variables vs. time. Virtually any circuit variable including currents and voltages internal to the semiconductor devices, may be displayed. Although no plotting capability is ordinarily supplied with CIRCUS, provisions have been made for saving variables on tape for subsequent plotting or further analysis by other programs.

LANGUAGE: FORTRAN H (93%), Assembler (7%)

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 6,987

PROGRAM NUMBER: MFS-15002

Weight Control System
(The Boeing Company)

The Weight Control System is a set of linked computer programs which provides weight and balance reports from magnetic tape files to be used for weight control and reporting in meeting specifications and standards in the production of vehicles. It was developed for use with launch vehicle programs, but can be used in the design of any aerospace, marine, or land vehicle (with minor modifications).

It maintains a complete weights file (by effectivity) and obtains effective weight reports of: (1) Detail Weight Listing, (2) Uniform Weight Distribution, (3) Actual Weight, (4) Cable Assembly, (5) Required Procedure Report, (6) Weight Status Report. Also, working reports are generated for use by a Weight Control Group. Weights information is supplied by sources such as engineering design, vendors, and manufacturing organizations. All information is run against the weights master files and a routine checks all unit records for the desired effectivity. Finally, formal and working tapes are generated from the resulting tape.

LANGUAGE: FORTRAN IV (98%), MAP (2%)

MACHINE REQUIREMENTS: IBM 7094/7044 Direct Couple System

NUMBER OF CARDS: Approximately 10,320

PROGRAM NUMBER: MFS-15028

Minimum Phase Program
(The Boeing Company)

In designing control systems, it is required to design a passive electrical network which satisfies specified gain and phase characteristics. It is assumed that a passive network can be constructed whose corresponding transfer function reflects stability of the network. If the minimum phase lag associated with a specified gain characteristic is less than a desired phase lag, then an actual electrical network can be constructed which will satisfy both gain and phase characteristics set forth by the engineer. The Minimum Phase Program determines the minimum phase lag of passive electrical networks reflecting the degree of stability of the transfer functions basically established by the gain characteristics determined by the engineer in the program input. The phase lag is determined in the program as a function of frequency for a specified gain characteristic.

To describe gain characteristics, the program user inputs a tabular array of gain versus frequency and two slopes. The slopes are used to define the gain curve for frequencies before and after the frequencies in the tabular defined region. The slopes are inputs. The integration technique employed is the trapezoidal method and the integration can be expressed as a function of frequency. The limits of integration are computed from a fraction and multiple which are multiplied by each c^{th} frequency value. The fraction and multiple integration limits are user input. The accuracy of the technique depends primarily on the increment used to form the base of each trapezoid. The user can divide the curve into three regions, each with its own frequency increment. The frequency increments are also user input.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 412

PROGRAM NUMBER: MFS-15045

Telemetry Data Conditioning System (DACON)
(The Boeing Company)

The Data Conditioning routines condition calibrated data with respect to linear interpolation, smoothing and decommutation for input to analysis programs. In addition, the package is capable of time base correction when extracting calibrated data.

It is assumed that, in addition to the input tape and output tape, if desired, a maximum of two scratch tapes are available to the package.

A maximum of fifty measurement numbers may be processed by the program with no smoothing and a maximum of ten measurements when smoothing is desired. An additional limitation is that only 480 flagged intervals can be processed for each measurement number due to storage limitations. A flagged interval is defined to be one or more flagged data values preceded and followed by a good value.

LANGUAGE: FORTRAN IV (99%), OBJECT (1%)

MACHINE REQUIREMENTS: IBM 7094/7040 Direct Couple System

NUMBER OF CARDS: Approximately 1,219

PROGRAM NUMBER: MFS-15049

Monte Carlo Direct View Factor and Generalized Radiative Heat Transfer Programs
(The Boeing Company)

These programs define a collection of simple geometric objects, called "Primary Surfaces", in three-dimensional space. The Monte Carlo Direct View Factor Program uses the Monte Carlo technique to find the "Black Body" view factor from a surface segment (Nodal Surface) defined on a Primary Surface to another surface segment defined on a Primary Surface. The collection of geometric objects includes a sphere, cylinder, cone, disc and parallelogram.

The Generalized Radiative Heat Transfer Program finds Radiative-Transfer Coefficients from a surface segment defined on a Primary Surface to all other surface segments defined in a real enclosure. This program permits radiation heat transfer analysis for enclosures containing surfaces which have, in general, both diffuse and specular reflectivities.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 3,272

PROGRAM NUMBER: MFS-15051

Fast Fourier Transform Spectral Analysis Program
(The Boeing Company)

This program was developed for use in analyzing postflight trajectory data emanating from space vehicle telemetered flight data. Except for input-output formats, the program can be adapted to handle any sampled data at even time increments. The program performs frequency spectrum analysis of the telemetered data, including a capability to calculate power spectrum, RMS amplitudes and cross spectrum of sampled parameters at uniform time increments.

The fast Fourier transform is a computational tool which facilitates signal analysis such as power spectrum analysis and filter simulation by means of computers. It efficiently and economically computes the discrete Fourier transform of a series of data samples at speeds up to 100 times faster than conventional methods.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: **Approximately 634**

PROGRAM NUMBER: MFS-15062

Data Documentation and Computer Filing/Retrieval System for Historical Events
(North American Rockwell-Space and Information Systems Division)

This system consists of data documentation, filing, and retrieval and reduces the time and cost of building up and maintaining a detailed chronological listing of historical events and related reference information. The system was developed around a specially designed Historical Event Information Card. The card permits both manual and computer filing and retrieval of historical data. Filing is done by date of event, while retrieval can be made by either date of event or by the event's relevance to a combination of factors such as program, contract, project, product number, system, structure, activity, location, or management organization. The computer program automates the filing and retrieval effort. Users of the system can develop their own retrieval codes according to need from guide lines given in the detailed description of the system.

LANGUAGE: COBOL

MACHINE REQUIREMENTS: IBM 360, Model 65, Release 11

NUMBER OF CARDS: Approximately 497

PROGRAM NUMBER: MFS-16155

Aerodynamic Heat Transfer Program
(North American Rockwell-Space and Information Systems Division)

This program is designed to compute all pertinent local aero-thermodynamic flow properties and aerodynamic heat transfer coefficients at any point on a typical high speed aerodynamic composite configuration made up of cones, cylinders, and frustums. The analysis is conducted for a range of mach numbers with corresponding trajectory and atmospheric data and includes angle of attack effects. Input and/or output may be in British or International units.

The program is based on theoretical methods and available experimental data. Both inviscid and viscous flow analyses are used to compute local flow properties and aerodynamic heat transfer rates on boost type vehicles consisting of cones, frustums, and cylinders. The general approach is to assume all flow outside the boundary layer as adiabatic, establish static and total pressure distributions, and then use turbulent flatplate theory for aero heating. Results may be obtained for Mach numbers ranging from near zero to fifteen and vehicle angles of attack from 0 deg. to 15 deg. for configurations with cone and frustum half-angles of 5 deg. to 35 deg.

LANGUAGE: FORTRAN IV (11%), MAP (80%), OBJECT (9%)

MACHINE REQUIREMENTS: IBM 7094, SC 4020 CRT output

NUMBER OF CARDS: Approximately 4,303

PROGRAM NUMBER: MFS-16234

High Speed Line Printer, CDC 1612-G, Verification Test
(North American Rockwell-Space and Information Systems Division)

This program automatically verifies the on-line operation and capabilities of the CDC 1612-G High Speed Line Printer which is a part of the CDC 924-A computer system.

The printer test is initiated by verifying the page eject codes three successive times. Following this, the single, double, and triple space capabilities are verified. The interrupt circuit is verified by printing one full line of each character using automatic single space between lines and interrupting on Printer Ready. Finally, all characters are printed on one line and are shifted by one character for the next line. This insures a pattern that allows every character to be printed at least once per each column.

LANGUAGE: CDC 924-A Assembly Language

MACHINE REQUIREMENTS: CDC 924-A

NUMBER OF CARDS: Approximately 324

PROGRAM NUMBER: MFS-16346

Decommutation Program
(North American Rockwell-Space and Information Systems Division)

This program decommutates specified data channels from a 1-inch digital tape to a 1/2 inch digital tape using a history tape as a source of decommutation information. A specific category of measurements on the history tape may be specified by card input.

The decommutation of data is usually a hardware operation external to the computer; therefore, the problems arise of how to determine when certain status and/or error conditions (such as parity errors, buffer overflow, data dropout, or equipment malfunctions) occur, and then, of what action to take. This program solves the problems by the incorporation of an interrupt monitoring system which provides communication between the computer and the involved external hardware.

Prior to starting the decommutation, each involved interrupt is linked with a processing routine in the computer. Then, during the decommutation, if a condition arises to cause an interrupt, control in the computer is switched to the appropriate processing routine where the exact nature of the interrupt is analyzed and the appropriate action taken.

LANGUAGE: SDS 920 Assembly Language

MACHINE REQUIREMENTS: SDS 920

NUMBER OF CARDS: Approximately 2,809

PROGRAM NUMBER: MFS-16347

Program for Calibration of Standard Resistors (STRES)
(North American Aviation-Rocketdyne)

This program produces, for a standard resistor, a table of temperature vs. resistance from the following formula:

$$R_T = R_{25} [1.0 + A (T-25) + B (T-25)^2]$$

where

R_T = Resistance, in ohms, at the given temperature

T = Temperature in degrees C

R_{25} = Resistance, in ohms, at 25 degrees C (input)

A = Alpha coefficient in parts per million (input)

B = Beta coefficient in parts per million (input)

The table values are computed for a fixed temperature range from 15 degrees C to 35 degrees C, in increments of 0.05 degrees C.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Version 11

NUMBER OF CARDS: Approximately 94

PROGRAM NUMBER: MFS-18140

(LABCON) Laboratory Job Control Program
(North American Rockwell-Rocketdyne)

The LABCON program provides a budget control system in a component test laboratory whose workload is made up from many individual budgetary allocations. A job requiring laboratory effort requires the combined support of several groups and a common denominator is applied to an incoming job, to which all effort is charged and accounted for. The common denominator is the Laboratory Job Number System and the facilities of the Data Processing Department. A job comes in and is inserted into the computer through a Job Input Data Sheet; it is numbered and a prime unit or group is realized along with the other units who will work on it.

Each employee makes out a Weekly Job Card each week. This form has a keypunch format, and contains spaces for the employee's serial number, straight time hours, overtime hours, and Laboratory Unit Code. The computer program will tally all hours worked against this given Job File Number each week and carry these hours over from week-to-week so that, when this job is finally completed, all laboratory effort generated by the request is compiled.

The unit code number serves as a function and/or equipment utilization code. This code will provide, through selected sort and list operations, valuable information required for proposals and equipment justifications, based upon the amount of loading on a particular facility, system or function.

LANGUAGE: PL1

MACHINE REQUIREMENTS: IBM-360, Release 11

NUMBER OF CARDS: Approximately 319

PROGRAM NUMBER: MFS-18141

NFL Site Performance Program
(North American Rockwell-Rocketdyne)

This program performs site performance reductions and provides performance data in appropriate units. It processes a maximum of ten slices of engine test data for selected parameters consisting of pressure, temperature and frequency parameters, covering several different propellant flow measurement configurations. Data for this reduction is recalled from disc locations containing scaled data stored by the NFL Parameter Reduction Program. However, it can be modified and adapted to site performance reductions for any installation; but the data for the reduction must necessarily be different.

Total weight flow and mixture ratio calculations are made using the coefficients from a model tenth order polynomial describing propellant weight flow as a function of inlet pressures and temperatures. The computer reduction time provides a test engineer with the opportunity to make quick decisions regarding malfunctions, parameter repair and adjustment, and subsequent testing schedules.

LANGUAGE: DAP Assembly Language

MACHINE REQUIREMENTS: Honeywell DDP-116, Astrodata 4024 Aquisition System

NUMBER OF CARDS: Approximately 2,182

PROGRAM NUMBER: MFS-18271

Thermal Analyzer Program (TAP)
(North American Rockwell-Rocketdyne Division)

This program solves N-dimensional transient heat transfer problems by the analysis of an analogous network of nodes joined by conductors. A capacitance, C, a heat generation rate, Q, and a temperature, T, are associated with each node. A conductance, K, is associated with each conductor.

The object under study is divided into convenient volumes, called nodes. Each node is assigned an identification number. The conductors represent resistance to heat transfer by the various heat flow paths; i.e., conduction, convection, and radiation. The temperatures at all nodes are computed at successive time intervals.

The network parameters, K and C, may be constant or functions of temperature and/or time. The heat generation, Q, may also be a function of temperature and/or time. If variable, K, C, and Q are evaluated at the beginning of each time interval. In addition, the temperature, T, may be specified at any node as a function of time.

The conductors may represent conduction, convection, or radiation paths. Convection and radiation are evaluated at the beginning of each time interval. Conduction, if variable, may be made a function of the average temperature of the two connecting nodes. Such conduction is evaluated at the beginning of each time interval.

The program is unable to handle pure steady-state problems; however, any node may be made a steady-state node (so long as it is not connected to any other steady-state node) by assigning to its capacitance the value zero. Temperatures computed for linked zero-capacitance nodes can be in error.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 1,061

PROGRAM NUMBER: MFS-18410

Resistor Calibration Program
(North American Rockwell-Rocketdyne Division)

This program computes the resistance, average resistance, and precision of a stock resistor by comparing it to a standard resistor.

The input consists of the ohms and serial number of both the standard resistor and the tested resistor, a code number for the principal standard, and the resistance of the standard. This information is followed by the voltage drops of the comparison standard and the test resistor.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 38

PROGRAM NUMBER: MFS-18412

Gamma Function
(North American Rockwell-Space and Information Systems Division)

This program is designed to evaluate the Gamma function defined by the equation:

$$\Gamma(\alpha) = \int_0^{\alpha} x^{\alpha-1} e^{-x}\, dx$$

$\Gamma(\alpha)$ is evaluated by an approximation formula employing Chebyshev polynomials in the interval $2 \leq \alpha < 3$. The approximation formula has the following form:

$$\Gamma(2 + x) \equiv \sum_{v=0}^{n} A_v x^v, \text{ where } 0 \leq x < 1 \text{ and}$$

A_v, $v = 1, 2, .. n$, is a determined set of coefficients contained within the program.

When α does not lie in the interval the equation

$$\Gamma(x + 1) = x\,\Gamma(x)$$

is employed to permit the use of the given approximation formula.

This routine will not evaluate the gamma function for $\alpha > 34$. The results that are returned are accurate to seven significant figures.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 55

PROGRAM NUMBER: MSC-338

Iteration of Exact Heat Conduction Solutions
(North American Rockwell-Space and Informations Systems Division)

The program investigates one-dimensional heat conduction within a semi-infinite body with a fixed surface and no mass transfer or surface re-radiation.

The program was needed to calculate isotherm depths from the exact solutions of temperature as a function of depth and time. The rate of heat transfer to the surface is assumed to be a triangular pulse. These calculated isotherm depths will then be compared with those obtained from the trajectory synthesis method.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 92

PROGRAM NUMBER: MSC-342

Matrix Reorthogonalization Routine
(North American Rockwell-Space and Information Systems Division)

The program restores the property of orthogonality to a near-orthogonal matrix.

Let: U be a 3 x 3 matrix to be orthogonalized

U^t be the transpose of U

I be the identity matrix

V be the approximation

$D = U^tU-I$

Then: $V = U (3/2\ I - 1/2\ U^tU)$

A sufficient condition for the convergence of the process described by the above equation is that $R(D) < 1$.

Where $R(D) = \max_i \{_j \Sigma|a_{ij}|\}$

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 44

PROGRAM NUMBER: MSC-351

Matrix Inversion Routine
(North American Rockwell-Space and Information Systems Division)

This subroutine inverts an N x N non-singular matrix. Given an N x N non-singular matrix A, A^{-1} can be obtained iteratively by using the following theorem: "If a square matrix, A, is reduced to the identity, I, by a sequence of row operations, the same sequence of operations applied to I will give a matrix which is the inverse of A." The original matrix, A, is not destroyed in the inversion process.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 78

PROGRAM NUMBER: MSC-362

Inverse Interpolation of Identity Function (GESWEL)
(Manned Spacecraft Center)

This program is used to find a solution (if there is one) by iteration to any equation of the form F(X) - X = 0. The program may be used to solve non-linear equations. It will solve problems of the following type:

Suppose that X_G is a guess at some end condition and X_R is the result of operating on X_G through some system. GESWEL selects the X_G such that $X_G \approx X_R$. This is identical to solving the equation X = f (X) where f is the system.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7090/7094

NUMBER OF CARDS: Approximately 68

PROGRAM NUMBER: MSC-411

Iterative Linear Approximation for Equation Solving With Initial Estimate (SEARCH)
(North American Rockwell-Space and Information Systems Division)

This program represents a positive method for the approximation of the solution of non-linear equations. The program calculates the value of the X-coordinate of a function of X when the value of the Y-coordinate and an initial estimate is given.

Letting $F(X) = Y$ be any function and Y_{GOAL} be some desired point, from a user supplied initial value X, SEARCH finds two values of the independent variable, X_L and X_H, such that $F(X_L) < Y_{GOAL} < F(X_H)$. The program then iterates by linear interpolation to find X_{GOAL} such that $F(X_{GOAL}) = Y_{GOAL}$.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 7090/7094

NUMBER OF CARDS: Approximately 51

PROGRAM NUMBER: MSC-412

Iterative Linear Approximation for Equation Solving Without Initial Estimate (SEARCH)
(North American Rockwell-Space and Information Systems Division)

This program represents a positive method for the approximation of the solution of non-linear equations. The program calculates the value of the Y-coordinate of a function of X when the value of the Y-coordinate is given.

By letting F(X) = Y be any function and Y_{GOAL} be a desired point, and without requiring a user to have an initial value of X, SEARCH finds two values of the independent variable, X_L and X_H, such that $F(X_L) < Y_{GOAL} < F(X_H)$. The program then iterates by linear interpolation and finds the X_{GOAL} such that $F(X_{GOAL}) = Y_{GOAL}$.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 7090/7094

NUMBER OF CARDS: Approximately 63

PROGRAM NUMBER: MSC-418

Analysis of Non-Linear Turbine Flowmeter Calibration Data
(North American Rockwell-Space and Information Systems Division)

This program minimizes flowmeter error due to non-linearity. This is done by fitting the flowmeter curve of calibration data points with a Lagrange Polynomial. The three-point Lagrange Polynomial interpolates between calibration data points. The program initially selects the first three calibration points and interpolates incrementally using the Lagrange Polynomial between the first and second data point. It then advances one data point, dropping off the first data point and interpolates between the second and third point. This process continues until all data points have been used. The tabulated data of flow rate versus period is printed out in small increments.

The program is dimensioned for inputting up to 200 calibration data points and for calculating up to 4,000 interpolation points. The only restriction is computer storage capacity.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 85

PROGRAM NUMBER: MSC-10069

Range and Time Characteristics Along A Constant G Path
(North American Rockwell-Space and Information Systems Division)

This program computes the range and time characteristics for flight along a constant load factor for a given initial velocity. The values computed represent the range from the given velocity to the sea level impact velocity. The range and time are both functions of the Earth's gravity, lift to drag ratio, velocity, and the constant load factor (G). For each load factor, the velocity may be incremented by a given value of ΔV and the new velocity is set equal to the initial velocity and a new load factor determined.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 37

PROGRAM NUMBER: MSC-15054

Determination of h Limit in the Supercircular Velocity Region
(North American Rockwell-Space and Information Systems Division)

This program computes limiting values of altitude rate (h_{LIM}) applicable to flight in the supercircular velocity region. The altitude rate limit is that actual value of altitude which the vehicle could safely have at a given combination of velocity, load factor, and aerodynamic characteristics without exceeding the supercircular overshoot boundary. The equation for computing $\dot{h}_{LIM}$ is an approximate equation which is useful for entry guidance applications. The altitude rate is a function of the lifting acceleration capability (A) of the vehicle (which can be written in terms of the total load factor and maximum lift-drag ratio of the vehicle) and the lifting acceleration required (B), as well as the scale height, lift-drag ratio, gravity, and velocity.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 63

PROGRAM NUMBER: MSC-15073

COMSITE
(North American Rockwell-Space and Information Systems Division)

The COMSITE program has been designed to (1) accept the test procedures written in a source language for SITE testing devices, (2) convert the mnemonic codes to machine language codes, and (3) simultaneously generate a machine language program on punch tape with which to operate the SITE equipment. The program is referred to as the Meta-Assembler.

The primary advantage of the Meta-Assembler is its ability to take each statement written in the source language and convert it into the many machine language instructions required. By this means, coding of a relatively few words can produce a program of fair size and complexity. Another advantage is error reduction. Whereas the Meta-Assembler cannot reduce errors written in the original source program, the possibility of errors is lessened, as the Meta-Assembler is generating most of the coding, thus minimizing any unpredictable human tendency to err in coding.

COMSITE is a two-pass Meta-Assembler internally. Pass 1 accepts and examines the input of the source statements, detects errors in the coding which violate the rules for COMSITE language formation, assigns test numbers, operates on the input, and stores the input in readiness for the second pass. Pass 2 converts the input to machine language codes, generates the object program, lists the object program on the printer, and punches the object program on tape.

LANGUAGE: FORTRAN IV (64%), MAP (21%), OBJECT (15%)

MACHINE REQUIREMENTS: IBM 7094 (Emulator on IBM 360/60)

NUMBER OF CARDS: Approximately 17,041

PROGRAM NUMBER: MSC-15212

Ramapo Pound Per Second Table Program
(North American Rockwell)

The Ramapo Pound Per Second Table Program will print out the control number, the serial number of both subject flowmeter and the flowmeter calibrated with it, the range of calibration (high, medium or low), the place and date of calibration, the medium used during calibration, the propellant for which the flowrates are valid and the degree of curve used to generate the pound per second table.

LANGUAGE: FORTRAN H

MACHINE REQUIREMENTS: IBM 360, Release 11

NUMBER OF CARDS: Approximately 253

PROGRAM NUMBER: MSC-15925

Transient Analysis Generator (TAG)
(Jet Propulsion Laboratory)

The Transient Analysis Generator program is designed to provide a means for simulating both transient and DC steady-state behavior of a large class of electrical networks. A very large class of lumped linear, bilateral, passive networks are covered by this analyzer, as well as a significant number of non-linear, nonbilateral networks which are simulated. The program generates a special analysis program for each circuit described to it. Program readability allows the user to check the actual equations that are generated to simulate the behavior of a particular circuit.

The TAG system consists of two basic parts. The first part which actually generates the solution program, is called the generator or preprocessor. The preprocessor interprets the user's circuit description, generates the proper set of simulation equations and imbeds them in a FORTRAN solution program. This solution program is unique to the given circuit topology and is available in punch-card form as output from the TAG system.

The second part is the execution or simulation system. This system comprises the set of subroutines required to actually run a generated solution program. These subroutines provide the detailed solution and control processes required by the simulation program. While the preprocessor is stored on magnetic tape to be called into use by special control cards, the execution system is stored on cards in relocatable binary form and must be included in all TAG system decks submitted for simulation run.

LANGUAGE: FORTRAN II(40%), FAP(40%), OBJECT (15%)

MACHINE REQUIREMENTS: IBM 7094, SC 4020 plotter

NUMBER OF CARDS: Approximately 9,972

PROGRAM NUMBER: NPO-10031

Interval Arithmetic Package, and Single and Double Precision Interval Arithmetic Linear Equation Solver and Matrix Inverter
(Jet Propulsion Laboratory)

This subroutine package makes it possible to express the result of a calculation $x \mapsto f(x)$, where x is a point in an n-dimensional coordinate space and f is a real valued map which involves arithmetic operations and certain elementary functions, in the form $f^*(x) \pm e(x)$. This result is completely rigorous in the sense that the statement $f^*(x) - e(x) \leq f(x) \leq f^*(x) + e(x)$ is true.

The Interval Arithmetic Basic Package, Version III, allows the user to incorporate interval arithmetic into computer applications with a minimum of programming effort. For example, performance of interval arithmetic where one of the operands is a scalar or degenerate interval number is now possible. Also available are interval replacement, interval change of sign, and the status of an interval relative to zero. These routines are in both single and double precision.

The Range Evaluation of Elementary Functions Package includes several routines which calculate the range of a given scalar function over a given interval in its domain. Rigorous bounds are obtained for the end points of the range intervals.

The Single or Double Precision Matrix Inversion or Linear Equation Solution Packages are used:

1. To obtain the number of significant digits calculated in an approximate solution to the problem $Ax = b$, where every element of both A and b can be represented exactly as floating point binary numbers. The number of significant digits can be obtained by comparing the numbers y^{ℓ}_{ij} and y^{r}_{ij}, the end points of the components of the interval matrix y^I.

2. To obtain a vector y^I which contains the solution to $A^I x^I = b^I$ where A^I is an interval matrix and b^I is an interval matrix. A^I and b^I can be specified to reflect uncertainties in the data and errors in the conversion of the data to IBM 7094 floating point binary. In particular, the double precision version can be used to display the dependence of an approximate solution on errors in the input data.

LANGUAGE: FORTRAN IV (40%), MAP (60%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 4,419

PROGRAM NUMBER: NPO-10500

Fourier Transform Technique for Prediction of Torsional Pulse Environment
(Jet Propulsion Laboratory)

This program utilizes a frequency-domain solution for determining the torsional acceleration transient occurring at booster engine cutoff for the Surveyor spacecraft, using the Ranger data. First, the Fourier transform of the transient acceleration, which occurred at the base of the spacecraft during the Ranger flights, is computed. A torque at the gimbal blocks is assumed to be the cause of this acceleration. The structural characteristics of the Atlas/Agena/Ranger vehicle are introduced in the form of a transfer function computed from the normal modes of the structure for viscous or hysteretic damping. Then the Fourier transform of the torque at the gimbal blocks is deduced.

The next step is the computation of the transfer function of the Atlas/Centaur/Surveyor vehicle, also using the normal modes of the structure. Then the Fourier transform of the transient acceleration at the Surveyor field joint is determined, assuming that the same torque is present at the gimbal blocks of the Atlas engine for both spacecraft, since the same booster is used. Finally, the time history of the Surveyor field joint acceleration is computed by inverse Fourier transformation.

Although the method is illustrated for the Ranger and Surveyor spacecraft, it is quite general and can be applied to any spacecraft for which the same booster is used.

LANGUAGE: FORTRAN IV (76%), MAP (24%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 1,540

PROGRAM NUMBER: NPO-10503

Shock Spectrum Analysis Program
(Jet Propulsion Laboratory)

This program computes the shock spectrum of a signal that has been digitized and formatted on digital magnetic tape. The spectrum values represent the peak acceleration response of a simple mechanical oscillator to an acceleration transient, $\ddot{x}(t)$, applied as a ground or base acceleration. The peak acceleration response is considered to be a function of oscillator natural frequency.

Using a recursive filtering technique, two different shock spectra are found: the primary and the residual. The primary shock spectrum consists of those values of peak acceleration response selected from the $\ddot{y}(t)$ time history over the portion of time for which $\ddot{x}(t)$ is defined. The residual spectrum consists of those values of peak acceleration response occurring in time after that portion of time for which $\ddot{x}(t)$ is defined. Although the forcing function, $\ddot{x}(t)$, is assumed to be zero outside the range for which it is defined, the response may continue, leading to nonzero residual spectra.

LANGUAGE: FORTRAN IV (68%), MAP (23%), OBJECT (9%)

MACHINE REQUIREMENTS: IBM 7094 with SC-4020 Plotter

NUMBER OF CARDS: Approximately 1,079

PROGRAM NUMBER: NPO-10528

Coupled Cavity Maser Noise Temperature
(Jet Propulsion Laboratory)

This program has been designed for the analysis of the equivalent noise temperature of cascaded negative—resistance maser amplifiers separated by isolators. The principal noise contributions in the amplifying section are (1) amplified noise from the preceding stages, (2) cavity losses and internal spin temperature contributions, and (3) noise from the output, including thermal noise and transmitted noise produced by the finite reverse attenuation of the isolators.

The effective noise temperature is determined by calculating the noise contributions of the various circuit elements, accounting for their gains, summing, and referring the net contributions to the amplifier input. The output of the program includes curves for various gain, loss, reverse isolation, and maser inversion ratios.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN IV	FORTRAN II
MACHINE REQUIREMENTS:	IBM 7094	IBM 1620
NUMBER OF CARDS:	Approximately 115	Approximately 113
PROGRAM NUMBER	NPO-10590	NPO-10590

Optimum Efficiency Elliptical Collector for a Compact Arc Lamp
(Jet Propulsion Laboratory)

This is a program which enables one to select an elliptical collector for a compact arc lamp which will pass the maximum energy through a system aperture at the second focus. The program is based upon the polar irradiance of the lamp, but absolute values need not be used since no attempt is made to determine absolute performance figures. System efficiency is calculated by comparing percentage of energy passed through the aperture to the total energy available from the lamp. The accuracy of the method is determined mainly by the accuracy of the relative polar irradiance numbers, the size of the polar angle increment and the values of the ERATO function. Examination of the specific application of the program should be used to determine its suitability. No study has been made of accuracy, but results comparing different known systems very closely match empirical test data. The accuracy of ERATO and BRITE values should be carefully determined to assure accuracy of results.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 1620

NUMBER OF CARDS: Approximately 318

PROGRAM NUMBER: NPO-10608

Atmospheric Attenuation Estimates from Radio Astronomy Measurements
(Jet Propulsion Laboratory)

Microwave and millimeter-wave observations of extraterrestrial radio sources are affected by the opacity of the earth's atmosphere, primarily because of oxygen and water content. This program is a method for relating a set of experimental data to the atmospheric opacity and intensity of an extraterrestrial source in order to study the properties and constituents of the atmosphere.

For a plane earth approximation, the equivalent noise temperature (T) of a radio source is related to the measured temperature (T') by

$$T' = TL_0^{-\sec Z}$$

where

L_0 = atmospheric attenuation at zenith, ratio (>1)

Z = zenith angle, degrees

The best value in a statistical least squares sense for T and L_0 is estimated from a series of measurements of T' and Z at various zenith angles. The bias errors normally encountered by linearizing with logarithms are avoided by linearizing with a Taylor series expansion and solving by iteration. In addition, the measurement errors for L_0 and T are estimated from the statistical data scatter.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094/7044 Direct Couple System

NUMBER OF CARDS: Approximately 162

PROGRAM NUMBER: NPO-10609

Calibration of Microwave Thermal Noise Standards
(Jet Propulsion Laboratory)

Calibrated microwave thermal noise standards usually consist of a matched element which is thermally isolated by a transmission line. This program calibrates these noise standards, accounting for arbitrary losses and temperature distributions along the transmission line. An iterative computing technique is used to transfer the source termination temperature (T) at (X=0, i = 1) to the output of the transmission line at (X = ℓ, i = n). The transmission line loss distribution must first be determined by measuring the total loss ($\bar{\bar{L}}_i$) in db at various temperatures ($\bar{T}_i$). A curve fit is determined from:

$$\bar{\bar{L}}_i,db = A_1 + A_2\,\bar{T}_i + A_3\,\bar{T}_i^{\,2} + - - -$$

and the constants A_1, A_2 --- (used as input data). The operational temperature distribution along the transmission line entered as a table, X_i versus T_i, completes the required input data.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094/7044 Direct Couple System

NUMBER OF CARDS: Approximately 100

PROGRAM NUMBER: NPO-10610

(VERGE) Subroutine to Accelerate Convergence of Iterative Processes (Westinghouse Astronuclear Laboratory)

VERGE is a general-purpose FORTRAN IV routine which is designed to accelerate the convergence of iterative processes and can be used to solve the many equations encountered in the numerical solution of engineering problems which do not permit explicit solutions for certain variables. Iteration is often the only effective means of solving non-linear algebraic and transcendental equations. Therefore, the general class of problems which is of interest is that which may be written in the form $x = f(x)$.

The routine is based on the convergence algorithm of Wegstein. The method accelerates the rate of convergence if the iteration converges, and it induces convergence if the basic iteration process tends to diverge. The convergence is quadratic which means that asymptotically the number of correct decimal places is doubled at each step. The method is analogous to the graphical procedure of finding the intersection of curves $y=x$ and $y=f(x)$, except that the process is automated. Iteration is started with a guess, from which the subroutine derives an improved estimate, and the process continues until the difference between successive estimates is arbitrarily small. In addition, underflow protection is provided so a search for roots close to the origin will not violate machine limits.

LANGUAGE: CDC FORTRAN IV

MACHINE REQUIREMENTS: CDC 6600

NUMBER OF CARDS: Approximately 70

PROGRAM NUMBER: NPO-10614

Numerical Filter Program
(Jet Propulsion Laboratory)

A linear weighting operator may be developed and applied to an information retrieval problem to eliminate an unwanted signal and to reconstruct a desired signal if sufficient information about the spectrum of an input signal is given. The development of a linear operator in terms of suitable weights is based on the selection of a frequency response function whose Fourier transform yields a time sampled version of the filters weighting function. This is a general numerical filter program and the filter (smoothing) techniques presented are valid for sequences of equidistant data. It may be used for signal detection and extraction, and general data smoothing.

The Fourier integral transformation and the convolution integral are the basic tools used in the design of numerical filters.

Inputs to the program consist of the data sequence to be operated on and five constants: (1) the maximum sample index, (2) the right-hand endpoint of the passband, (3) the lefthand endpoint of the passband, (4) the sampling interval, and (5) the number of input data values printed.

Outputs include listings of the input and output data values and two plots of the input signal and of the output signal. A sketch of the analytical background and a discussion of parameters which are critical for this numerical filter program are also presented. The outputs are provided with one option to ensure simplicity in using the program and maximum case in interpreting results.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094 or SDS 930

NUMBER OF CARDS: Approximately 209

PROGRAM NUMBER: NPO-10723

Least Squares Weighted Cosine Curve Fit
(Jet Propulsion Laboratory)

This program is used to fit experimental data y to a cosine curve a-b cos $(\phi + \alpha)$, in a least squares sense. The data can be weighted if desired. The variance of the data points y is given by

$$\sigma^2 = \frac{1}{n-3} \; w \; [y - a + b \cos (\phi + \alpha)]^2$$

where

n = number of data points

$$w = \text{weighting} = \left(\frac{1}{\text{probable error}}\right)^2$$

The constants a,b, and α necessary to minimize this variance are determined by differentiating with respect to each. The resulting equations are set equal to zero and solved for a,b cos α, and b sin α.

Computed values of constants a,b, and α are given; the equations for the statistical errors in a,b, and α are also programmed and the answers tabulated; and a tabulation of the input array, computed y values, and differences is also presented. A graph routine indicates the data points and the curve fit.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094/7044 Direct Couple System

NUMBER OF CARDS: Approximately 114

PROGRAM NUMBER: NPO-10724

DSN Seven Day/Twelve Week Schedule Program
(Jet Propulsion Laboratory)

The objectives of the Deep Space Network (DSN) are to simplify the procedure for allocating the DSN resources on both a medium-term and a short-term basis, to increase management visibility of DSN loading, to maximize the utilization of DSN resources, and to simplify the project/DSN interface.

The DSN Seven Day/Twelve Week Schedule System is basically a system of request, review, and allocation. The system accepts requests for usage of DSN equipment and resources from flight project and DSN users. These requests are sorted, accumulated, and composed by means of the program. Non-conflicting requests detected by the program are reviewed with reallocation of resources based on known priorities. To accomplish its functions, the program needs three basic types of information:

1. What DSN resources, in terms of facility, station, area, equipment, and communications, are available for scheduling.

2. Which items or what "configuration" of the DSN resources are required by a user to conduct a particular activity.

3. When and for how long the use of that particular configuration is requested.

With this type of information, the program allocates the DSN resources. The program can generate two types of schedules, depending upon the program input: Seven Day Schedule or Twelve Week Schedule.

LANGUAGE: COBOL (96%), MAP (4%)

MACHINE REQUIREMENTS: IBM 7094

NUMBER OF CARDS: Approximately 4,604

PROGRAM NUMBER: NPO-10752

ASTEFF-Asteroid Belt Effects Program
(Jet Propulsion Laboratory)

This program provides a method for minimizing the shielding mass for a given probability of zero meteoroid penetrations of the shield of a spacecraft with a trajectory in the ecliptic plane, through the asteroid belt. Trajectories in the ecliptic plane require more shielding mass for protection against meteoroids, whereas trajectories out of the ecliptic plane require more propulsion mass. A model of the asteroid belt, based on 1500 numbered asteroids, is employed.

A mathematical model is used for the probability, P(S), of successfully traversing the asteroid belt, or the probability, P(0), of zero penetrations of the spacecraft shield. The spacecraft is represented by a convex polyhedron. The spacecraft trajectory is assumed to be in the form of an elliptical orbit. The meteoroid capability of penetrating the spacecraft shield is included as a function of meteoroid size, density and relative velocity, and shield thickness, density and hardness. The probability, P(0), is calculated as a function of spacecraft size and shape, and of shield mass, composition, and distribution over the spacecraft surface.

Two cases are considered: A, uniform shielding over the entire surface of the spacecraft, and B, optimum shielding to maximize P(0) for a given spacecraft shape, size and shielding mass. Calculations are made for a 500- and 900-day mission spacecraft orbit. The program permits the parametric variation of the spacecraft mission trajectory, the asteroid belt model and the spacecraft shape, size and shielding material.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7090/94

NUMBER OF CARDS: Approximately 1,051

PROGRAM NUMBER: NPO-10771

Continuous Path Profiling for Two-Axis "Cintimatic" and "Acrocenter" Machines
(Jet Propulsion Laboratories)

Numerical control machines, such as the "Cintimatic" point to point type, are made primarily for straight line milling and drilling, such as square blocks, rectangular blocks, cavities and hole patterns. Tapes for these machines are made by typing the information by hand on a tape punch typewriter. There are some programs available for straight milling and drilling operations, but none that have been designed for contouring.

The new "Continuous Path Program" is designed for the IBM 1620 computer and includes the specific data input necessary to program the computer. This is so that any configuration in a two-axis plane such as a straight cut bending, to and including a radius, will be calculated, and the radius may then blend into a reverse curve or angle. These calculations are in the form of punched cards which are converted by a card to tape converter to a usable tape for the numerical control machines. There are also provisions for a complete plot which is made simultaneously by the computer to show any gross errors that may arise.

Their capable functions include bolt circles, random holes, random slots, D-holes, parabolas, ellipses, air foils, etc. Also, a "clean" operation is available to automatically mill the remainder of material from any size pocket to the periphery.

LANGUAGE: FORTRAN II

MACHINE REQUIREMENTS: IBM 1620

NUMBER OF CARDS: Approximately 4,009

PROGRAM NUMBER: NPO-10772

Parabolic Spline Interpolation Subroutine (SPLINT)
(Westinghouse Astronuclear Laboratory)

The SPLINT program performs interpolation and differentiation using the parabolic spline. This spline fit, while not as accurate as the cubic or higher order splines, can be generated by a closed-form expression. The method is analytically equivalent to taking four consecutive tabular points and fitting a parabola through the first three points and a parabola through the last three. The parabolic spline between the two middle points of the set is determined by linearly interpolating between the two parabolas. Continuity of the first derivative of the fitted curve is preserved.

A new search scheme was devised to permit the use of tabular data where the independent variable is either monotonically increasing or decreasing. This feature allows the subroutine to handle inverse interpolation directly, with the restriction that Y = F (x) and the inverse operation X = G (y) are both single valued. Also, in the interest of generality, a special indexing scheme is used to facilitate multidimensional interpolation. Endpoints and extrapolations are handled by letting the first three tabular points, or the last three, determine a parabola which defines the fit at the extremities of the table.

LANGUAGE: CDC FORTRAN IV

MACHINE REQUIREMENTS: CDC 3600 or CDC 6600

NUMBER OF CARDS: Approximately 249

PROGRAM NUMBER: NPO-10786

AGWRN-Decoding Routine for Selected Agiwarn (Ursigram) Messages (Jet Propulsion Laboratory)

This program decodes selected Agiwarn (Ursigram) messages on solar and geophysical data, as distributed daily by the International Ursigram and World Days Service. The original messages can be copied directly from the incoming teletype printouts to punched cards.

Five different commonly used messages can be decoded: Solar Flares (UFLAG, UFLAL), Solar Corona (UCORA), and Sunspots (USSPM, USSPO). Decoding takes place at a rate of approximately 5 to 10 records per average message length. The basic framework is set up so that subroutines for decoding other Agiwarn messages can be added easily. Messages which run over five punched cards cannot be handled.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 1130

NUMBER OF CARDS: Approximately 929

PROGRAM NUMBER: NPO-10792

Terminal Sterilization Process Analysis Program
(Jet Propulsion Laboratory)

To achieve the appropriate probability of sterility required by the planetary quarantine constraints, a dry heat thermal sterilization process may be applied to a planetary capsule prior to launch. To minimize the severity of the sterilization cycle and also assure that the desired level of sterility is attained, it is necessary to account for the reductions in microbial population that occur during the transient phases of heating and cooling as well as the reductions that occur during the steady state phase. This program, based on a logarithmic survival model, computes a measure of the sterilizing process, which, when equal to unity, is indicative that sterility has been achieved. The program then calculates the time necessary for heat application, the additional time required at steady state conditions, and the time necessary for cooling.

The basic required inputs are: (1) a thermal analysis of the capsule, (2) the probability of survival that must be achieved at the end of the cycle, (3) the microbial heat resistance characteristics, and (4) the number of microorganisms present at the time of capsule sterilization.

The program has considerable flexibility in the values the basic inputs can assume. For Version 1 (SPAN), the temperature profiles from the thermal analysis must be input on tape. The tape input is the output (rows and columns rearranged by a simple subroutine to meet the format requirements of SPAN input) of thermal analysis programs such as CINDA, Chrysler Improved Numerical Differencing Analyzer (see MFS-2298), or Lockheed's Thermal Analyzer Computer Program for the Solution of General Heat Transfer Problems. For Version 2 (SPAN C), the temperature profiles from the thermal analysis are input on cards. A maximum number of 250 profiles can be accommodated, including up to 2000 time points on each profile. The profiles can be in either degrees Fahrenheit or degrees Celsius. Each profile can have a different value for the probability of survival, the microbial heat resistance characteristics, and the number of microorganizms; or, if desired, a fixed value for a given run for any of these parameters can be assigned. Other parameters which can be varied include the temperature at which microbial reduction begins, reference temperature, and tolerances. Also available are several tape search options (SPAN only) and an alternate microbial reduction computation technique.

(continued on next page)

This program is primarily used in conjunction with a thermal analysis program for performing sterilization process calculations and sensitivity studies prior to sterilization of the capsule.

	VERSION 1	VERSION 2
LANGUAGE:	FORTRAN IV	FORTRAN IV
MACHINE REQUIREMENTS:	IBM 7094	IBM 7094
NUMBER OF CARDS:	Approximately 439	Approximately 489
PROGRAM NUMBER:	NPO-10804	NPO-10805

Calculation of Inertia Tensor Matrix and Center of Gravity of Complex Bodies
(Jet Propulsion Laboratory)

This program calculates the Inertia Tensor Matrix and Center of Gravity of a body from its component parts. For each component part, the Inertia Tensor Matrix is calculated about its own principal axes. Then, for each part, a new Inertia Tensor Matrix is calculated with respect to the body's reference axes (rotation), and all parts are combined (translation) to calculate the Center of Gravity and Inertia Tensor Matrix of the body.

The output of this program is in two parts. The first is a listing of the local (component part) moments and products of inertia after rotation; the second, the body Inertia Tensor Matrix and Center of Gravity after translation. The program may be used for either type of calculation, if desired.

LANGUAGE: FORTRAN II-D

MACHINE REQUIREMENTS: IBM 1620

NUMBER OF CARDS: Approximately 382

PROGRAM NUMBER: NPO-10827

Structural Analysis and Matrix Interpretive System (SAMIS)
(Jet Propulsion Laboratory and Langley Research Center)

SAMIS is designed to solve problems involving matrix arithmetic, with particular emphasis on structural applications. The program can execute, either exclusively or sequentially, two basic operations. From input data that define an idealization of a structure, the generation phase of the program generates structural matrices for any type of element available in the program element library. This phase is based upon the structural concepts of the finite element method, in particular, the stiffness or displacement method. To enable the program to analyze a range of structural types (truss, plate, shell, composite shell beam, etc.), several elements are programmed and cataloged in the program element library. Contained in the library are the general line element suitable for representing axial, bending, and torsion deformations, and the triangular plate element which models membrane and bending deformations. The second basic operation is termed the manipulative phase, in which either generated or input matrices are manipulated according to the rules of linear algebra. In structural problems, the matrix manipulations may be sequenced to compute displacements, stresses, reaction faces, or mode shapes and frequencies. The ability to compute these quantities for structural systems which are described by a large number of simultaneous equations requires greater than in-core data access and storage capacity. Because of this requirement, the program was developed as a chain system. Based mainly upon the constraint of computer running time, the SAMIS program operates efficiently with matrices ranging from the 100th to 2500th order.

The SAMIS program is now available in three versions. Version 1 Modification 3 is the final modification to the original FORTRAN II program. Version 2 Modification 1 is a FORTRAN IV version of SAMIS with the same capability that exists in the FORTRAN II version plus some new and extended capabilities which include a new modified Choleski or Gauss wavefront algorithm for solving a set of symmetric simultaneous equations; a new eigenvalue routine to obtain the roots and vectors of a real symmetrix matrix up to order 200 by Givens-Householder algorithm; and a new checkout and element data generation routine. Version 3, Modification 1 is a CDC-6600 FORTRAN program. This version is the equivalent of the FORTRAN II Version 1, Modification 1 program in performance.

(continued)

	V1M3	V2M1	V3M1
LANGUAGE:	FORTRAN II (99%) FAP (1%)	FORTRAN IV (98%) MAP (2%)	CDC FORTRAN
MACHINE REQUIREMENTS:	IBM 7094	IBM 7094	CDC 6600
NUMBER OF CARDS:	13,620	17,637	14,298
PROGRAM NUMBER:	NPO-10130	NPO-10839	LAR-10050

KAP-V, Calculation of Radiation Level at a Point From a Complex Radiation Source
(Westinghouse Astronuclear Laboratory)

This program applies the point Kernel technique to calculate the radiation level at detector points located within or outside a complex radiation source and shield geometry described by a combination of quadratic surfaces.

The program evaluates the material thicknesses intercepted along the line-of-sight from the source point to the detector point. These material thicknesses (or path lengths) then are employed in attenuation functions to calculate the flux, dose rate, or heating rate at the detector. The attenuation function for gamma rays employs exponential attenuation with a buildup factor. Three optional neutron attenuation functions are included: (1) a modified Albert-Welton function for calculating fast neutron dose rate using removal cross sections; (2) a bivariant polynomial expression for computing neutron spectra using infinite media moments data; and (3) a monovariant polynomial expression for computing neutron spectra using infinite media moments data.

The program also handles either cylindrical, spherical, disc, line, or point sources. Different source distributions may be employed for neutrons and gamma rays. A variety of options is available for describing the source distributions. The source distributions are assumed separable along the axis and radius of cylindrical-type source regions and independent of the azimuthal angular position for either spherical or cylindrical sources. An option is provided to describe azimuthal source density variation by specifying input data for discrete point sources.

The program is written for the IBM 7094. The running time is dependent upon the number of zones and boundaries along the path between each source point and each detector point. A typical complex problem would take an average of 0.01 seconds per source point for each detector point.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: IBM 7094 or CDC 6600

NUMBER OF CARDS: Approximately 1,960

PROGRAM NUMBER: NUC-10192

Flo Chart
(Wallops Station)

The Flo Chart program is designed to produce flowcharts of programs written in FORTRAN IV or FORTRAN II. The program gives the ability to revise charts easily and to produce at will accurate, readable diagrams of the program under consideration.

This program has several advantages over previous methods of manually drawing and revising detailed flowcharts. Other than obvious advantages of speed, minimum expense and quality of the product, there is a detail of the charts that allows the programmer to easily construct a higher level logic diagram. It is also a handy debugging tool, since charts may be produced at any time to assist in studying the program steps and their logical relationships.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: GE-625

NUMBER OF CARDS: Approximately 591

PROGRAM NUMBER: WLP-10030

Drag Coefficient
(Wallops Station)

This program calculates the drag coefficient of a vehicle, given the time, altitude, thrust and flight path angle. Previous methods of calculating the drag coefficient of flight vehicles were accomplished by the utilization of a desk calculator. This program offers the advantages of reduced time and effort and allows more than one case to be run consecutively if desired.

The weight is calculated at each data point. The average of time is found. The average of altitude, δ, thrust, velocity and weight is also found by the same formula, using the appropriate variable. Then the drag is found by

$$D = T_{avg} - W_{avg} \sin\delta_{avg} - \frac{W_{avg} AV.}{P_{avg} \Delta T}$$

and drag coefficient is $CD = \frac{D}{QS}$

where Q is dynamic pressure and S is the reference area of the vehicle.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: GE-625

NUMBER OF CARDS: Approximately 120

PROGRAM NUMBER: WLP-10032

Transform Program
(Wallops Station)

This program transforms latitude, longitude and height above spheroid from one geodetic coordinate system to another. It also punches out geodetic and geocentric latitudes, longitude and radius of the earth and height above spheroid in block data format.

The only limitation is that the number of reference points to be transformed must be $\leq$ 99. The program produces accurate conversions to be punched out.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: GE-625

NUMBER OF CARDS: Approximately 234

PROGRAM NUMBER: WLP-10033

Body Elevation
(Wallops Station)

When given the geocentric body elevation and flight azimuth of a vehicle at a given flight time and the geodetic and geocentric latitudes, the Body Elevation program computes the geodetic body elevation angle at that time. It also computes the average rate of change of the geodetic body elevation angle for each time given.

LANGUAGE: FORTRAN IV

MACHINE REQUIREMENTS: GE-625

NUMBER OF CARDS: Approximately 85

PROGRAM NUMBER: WLP-10034